PATENT SPECIFICATION

972,693

DRAWINGS ATTACHED

972,693

Date of Application and filing Complete Specification: Nov. 7, 1960.
No. 38234/60.
Application made in taly (No. 18439) on Nov. 7, 1959.
Complete Specification Published: Oct. 14, 1964.

Index at acceptance:—B3 D(1D3B, 1D3D, 1H4, 2A1, 2A6, 2A8, 2A15, 2A20)
International Classification:—B 24 b

COMPLETE SPECIFICATION

Machine for Smoothing and Polishing Natural and Artificial Stone Surfaces

I, LUIGI COLOMBI, of Via A. Fantoni 22, Bergamo, Italy, of Italian Nationality do hereby declare the invention for which I pray that a patent may be granted to me, and the method by which it is to be performed, to be particularly described in and by the following statement:

The present invention relates to a machine for smoothing and polishing natural and artificial stone surfaces of any character and in particular marble and the like.

The difficulty encountered in smoothing and polishing, particularly of very large surfaces, lies in the problem of obtaining by economical means perfectly uniform smoothing and polishing results over the entire surface treated. It has been particularly difficult to eliminate the so-called shadow traces which are particularly visible under obliquely reflected light.

The machines and processes known up to the present have not been able to solve this problem in a technically and economically satisfactory manner.

The present invention produces a uniform smoothing and polishing result over the entire surface treated without leaving traces or shadows.

The invention provides a low-cost machine suitable for carrying out smoothing and polishing natural and artificial stone surfaces in an automatic manner with the minimum employment of man-power.

While studying the above mentioned problems encountered in the technology of smoothing and polishing, it has been observed that it is possible to obtain a perfectly uniform smoothing and polishing result by repeatedly varying, until reversed, the direction of the smoothing motion.

According to the invention a flat surface grinding and polishing machine comprises of a polishing head with planetary arranged polishing and grinding tools having the polishing surfaces thereof rotating in their own planes and arranged perpendicular to the driving shaft of the polishing tools and with a carriage raisably and depressably supporting the said polishing head and adapted to run on carrying tracks which are movable in the direction transverse to the movement of the said carriage, characterized in that on said carriage a swinging transmission unit is arranged which co-operates with the driving shaft of the polishing head and imparts thereto additionally a circular swinging motion in a plane parallel to the grinding and polishing surface of the grinding tools.

The machine of the invention for the smoothing and polishing of natural and artificial stone surfaces of every character with the employment of movable smoothing and polishing means rubbing along the surfaces to be smoothed and polished, imparts to said smoothing and polishing means a mechanical rubbing motion over every point of said surface and in directing said mechanical rubbing motion according to directions of rubbing which are continually varying.

By the aid of this arrangement, in addition to the planetary motion and the oscillatory motion, said smoothing and polishing means can, as a unit, execute a fret-like motion.

Other characteristics, objects and advantages of the invention will appear from the following description of an embodiment of the device for executing the inventive idea, which embodiment is given merely for illustrative purposes and entirely without limitation of the invention hereunder and is illustrated in the accompanying drawings wherein:

Figure 1 shows a diagrammatic elevation view of the machine;

Figure 2 shows a diagrammatic plan view thereof;

Figure 3 shows a partial view of the right-hand side;

Figure 4 and 5 show longitudinal sections of the movable span;

Figure 6 shows a front view of the carriage

carrying the mandril;

Figure 7 shows a side view of Figure 6;

Figure 8 shows a plan view of the lower part of the carriage excluding the motors;

Figures 9 and 10 show sections respectively along the lines IX—IX and X—X of Figure 8;

Figure 11 shows a plan view from below of the lower part of the mandril to which the disc carrying the tools can be attached;

Figure 12 shows a section along the line XII—XII of Figure 9;

Figure 13 and Figure 14 show partial sections respectively along the lines XIII—XIII and XIV—XIV of Figure 8;

Figure 15 shows a plan view of the disc carrying the mandrils;

Figure 16 shows a cross-sectional view of Figure 15;

Figure 17 shows a perspective view from below, indicated by the arrow XVII of Figure 4, illustrating the device placed on the span for the automatic control of the alternate motion; and

Figures 18 to 21 show the working diagram of the machine;

Figure 22 shows a detail of one of the microswitches which control the automatic work cycle; and

Figure 23 shows a detail of the brake arranged on the shafts of the motors driving the carriage and the span.

Numeral 1 indicates a block upon which the slab L of marble, stone or artificial stone which is to undergo the operation of smoothing and polishing, is lain. At the sides of the block 1 two supports 2 and 3 are arranged with respect to which a span 4 laid longitudinally over the said block 1, is free to run transversely. Along the span 4 there is free to run a carriage 5 carrying a vertical mandril 6 to the lower end whereof there is fixed a disc 7 carrying a plurality of tools 8 having vertical axes and composed of abrasive members which perform the smoothing and polishing operation on the upper surface of the slab L.

The span 4 is provided at its ends with two pairs of grooved rollers 12 which run in two corresponding prismatic guides 11 attached to the top of the supports 2 and 3.

The carriage 5 is guided along the span 4 by means of four horizontal axis upper rollers 13 resting on the upper plane of the span, two horizontal axis lower rollers 14 resting on the lower plane of the span and four vertical axis rollers 15 resting on internal surfaces of the span.

The lower rollers 14 are arranged at the front edge of the span near the mandril 6 so as to absorb the vertical reaction of the action of the slab on the tools and on the mandril and therethrough on the carriage.

The movements of the span 4 with respect to the supports 2 and 3, are controlled by an electric motor 16 placed on one of the ends of the span. The said motor controls, through a belt drive 17 and a pair of helical reduction gears 18—19, a shaft 20 carrying a toothed wheel 21 rigidly mounted thereon which engages with a toothed rack 22 attached to the top of the support 3 parallel to the guide 11.

A shaft 23 is rigidly fixed coaxially to shaft 20 and runs the whole length of the span, carrying on its opposite end a toothed wheel 24 which engages with a toothed rack 25 placed at the top of support 2. The toothed wheels 21 and 24 thus act simultaneously and cause the span 4 to move transversely with respect to the machine supports 2 and 3.

The movement of the carriage 5 along the span 4 is controlled by an electric motor 26 situated on the upper left-hand side of the said carriage and driving, through a belt drive 27 and a pair of helical reduction gears 28—29, a shaft 30 whereon a toothed wheel 31 is keyed, which toothed wheel engages with a toothed rack 32 attached to the upper part of the span and extending longitudinally thereon.

The extent of the transversal travel of the span 4 is limited by a microswitch 33 forming part of the electrical circuit of the motor 16, the trigger whereof is controlled by an oscillating mechanism 34 which is shifted alternately to the extremities of the transversal travel of the span by reason of its counteraction against rods 35 and 36 carried by corresponding positioning blocks 37 and 38 fixed in adjustable positions with respect to a guide 39 on the support 3. The positions of the positioning blocks 37 and 38 determine the extent of the transversal travel of the span.

The rods 35 and 36 are attached to their corresponding positioning blocks 37 and 38 by means of springs 35*a* and 36*a* which allow the rods to yield elastically after coming into contact with the mechanism 34, in order to absorb the over-running of the span due to inertia at the moment of its reversal of movement.

A similar device is provided for limiting the longitudinal travel of the movable carriage 5 and for controlling the reversing of the movement thereof. The carriage has a microswitch 40 as part of the electrical circuit of the motor 26, which is operated by a mechanism 41 which co-operates with rods 42 and 43 carried by corresponding positioning blocks 44 and 45 adapted to be fixed in adjustable positions with respect to a longitudinal guide 46 formed in the span.

With reference to Figures 6 to 14 illustrating the carriage in detail, in the middle part of the carriage there is a sector 47 carried at one end by a vertical axis pivot 48 about which the sector is free to oscillate in a horizontal plane, being guided at the oscillating end by two pairs of rollers illustrated in detail in Figures 13 and 14. One pair of rollers 48′ is carried on fork supports 49 attached to two

upper plates 5*a* of substantially triangular shape forming part of the carriage. Said rollers 48' rest on the upper surface of sector 47 and thus prevent it from being shifted upwardly. The second pair of rollers 50 is carried by supports 51 attached directly to the sector 47. They rest on the lower part 5*b* of the carriage and thus prevent the oscillating sector from sinking downwardly.

The sector 47 carries on its oscillating end a tubular shaped support 52 with a vertical axis, which protrudes with respect to the lower part of the carriage and is arranged in front of the span 4.

The support 52, by means of a pair of roller bearings 53, 54, bears a sleeve 55 containing inside it the mandril 56 which is engaged in a prismatic coupling with the sleeve and hence can shift axially but cannot revolve relatively to the sleeve. To this end the mandril is formed with grooves 56*a* on its outside wherewith internal projections 55*a* in the sleeve engage.

At the top end of the sleeve 55 a grooved pulley 57 is keyed, and is connected through a set of belts 58 to an electric motor 59 mounted on the upper part of the carriage 5. Said motor 59 therefore controls the rotation of the sleeve 55 and of the mandril 56 at the end whereof a flange 60 is formed provided with shaped seats 61 on its periphery, which are used for the rapid attachment, by means of a bayonet movement, of the disc carrying the tools, which disc will be described hereinafter.

Round the lower groove of the pulley 57 a belt 62 which is shorter than the belts 58, engages and transmits the rotatory motion to a pulley 63 which forms part of a speed reducer 64 composed of a pair of helical gears, and attached to the central part of the oscillating sector 47. On the output shaft 65 of said helical speed reducer is keyed an eccentric 66 around which a connecting rod 67 is arranged which is attached at its other end to a pivot 68 fixed near one of the sides of the carriage 5.

The rotation of the eccentric 66 thus causes the connecting rod 67 to reciprocate and hence, by reaction, causes the sector 47 to oscillate about the pivot 48. The mandril 56, as a result of the rotation imparted by the motor 59, therefore performs a compound motion of rotation about its own axis and oscillation about the pivot 48 of the sector.

A vertically movable mechanism 69 is mounted on the lower end of the mandril 56. Said mechanism carried two vertical columns 71 (Figure 6) guided with corresponding bosses 72 which are solid with the tubular support 52. A pair of roller bearings 70 are arranged between the lower end of the mandril and the mechanism 69, which bind the two members in reciprocating relationship such that the mandril is allowed to rotate and both members may shift vertically.

The mechanism 69 carries a toothed rack 73 arranged vertically and attached thereto by the interposition of a spring 74 which allows the two members to make slight vertical movements relatively to each other the object of which will now be made clear.

The toothed rack 73 engages with a toothed wheel 75 the hub whereof is carried by a lower end-piece 52*a* of the support 52. Said end-piece also contains a helical speed reducer housed in a box 78. The helical gear of said speed reducer is solid with the aforesaid toothed wheel 75 and the worm gear is rigidly connected with a manually operable handwheel 79.

Turning the handwheel 79 causes, through the helical speed reducer 78 and the rack and pinion coupling 73 and 75, the vertical shifting of the mandril 56.

A locking screw 80 permits the locking of the control handwheel 79 to a fixed disc 81.

The rack 73 is provided with a groove 73a wherein a guide roller 82 carried by the end-piece 52*a* of the support, engages.

At the lower end of the mandril 56, in proximity of the flange 60, there is applied a tool-carrying disc which is illustrated in detail in Figures 15 and 16. Said disc includes an annular portion 83 rigidly attached to a central sleeve portion 84 carrying three upper projections 85 fitted with heads 85*a* which are adapted to become engaged by interlocking through a bayonet movement, in the corresponding seats 61 cut out of the flange 60 of the mandril.

The annular member 83 has four equidistant cylindrical seats arranged round a circumference, in each of which a shaft 86 is placed mounted on roller bearings 87 and 88. To each of said shafts 86 a corresponding tool is attached consisting, for example of an abrasive grinding wheel 89, preferably of cylindrical shape with a central hole, attached to a support 90 in the form of a cup. The support 90 is fitted with an upper nut 91 which can be screwed onto the threaded lower end 86*a* of the shaft 86. In this way the tools are easily and rapidly changed to suit different kinds of work and for replacement when worn.

On each of the shaft 86, in the space between the two roller bearings 87 and 88, a toothed wheel 92 is keyed. Said toothed wheels 92 engage with a toothed rim 93 arranged in the central part of the member 83 and guided in relation to it by means of a robust roller bearing 94.

The toothed rim is provided with two rings 95 protruding upwardly, to which teeth 96 are attached. Said teeth are adapted to be stopped by resilient blocks 97 carried by the mechanism 69 in order to prevent the rotation of the toothed rim 93 which thus behaves like the centre member of a planetary system with respect of the satellite pinions 92.

The grinding wheels 89, on account of the rotation of the mandril 56 to which the disc 83 is keyed, execute a movement of revolution

around the axis of the mandril and a rotatory movement about the vertical axis of the corresponding shafts 86; these shafts in fact roll around the planetary tothed rim 93 which is kept fixed by the teeth 96 being stopped by the blocks 97. The grinding wheels 89 have also a third movement of oscillation about the pivot 48 of the sector 47 carrying the mandril.

The compound movement of the tools permits a perfect polishing of the slab to be obtained without leaving streaks or shadows, thus obtaining a finish which until now has been obtainable only by hand.

The handwheel 79 allows an initial setting to be made of the vertical position of the tools in relation to the slab which is undergoing treatment. The grinding wheels are brought into contact with the slab and thereafter the handwheel 79 is given another small turn so as to lower the rack 73 to a certain extent. The spring 74 is thus loaded and ensures that the tools and the slab remain in contact during working. The tools furthermore are able to go on being lowered under the pressure of the spring 74, as a consequence of the wearing down of the slab under treatment.

Referring to Figures 10 and 18 to 21, the electric motors 16 and 26 which drive respectively the transversal movement of the span and the longitudinal movement of the carriage, are controlled not only by the travel-limiting microswitches 33 and 40, but also by the microswitches 100 and 104 (see Figure 18), the first mentioned of which is affixed to the bottom right end of the span and is controlled by a rotating cam 101 carried by the shaft 23 of the span. Said cam 101 consists of a cylindrical mass which can be radially shifted in relation to a fork support 102 fixed rigidly to the shaft 23. A spring 103, placed between the fork support 102 and the mass 101, tends to make the said mass approach the shaft 23, while the centrifugal force generated by the rotation of the shaft 23 tends to move the mass 101 radially outwardly in such a way that it can engage the trigger of the microswitch 100.

Thus the rotating mass or cam 101 is detached from the trigger of the microswitch after it has actuated it, if it should happen to be stopped just on top of the switch, thus allowing the work cycle to be resumed from any position.

The microswitch 104, on the other hand, is carried by the rear portion of the carriage and is actuated by a rotating cam consisting of a mass 105, identical to the aforesaid mass 101, radially movable in relation to a fork support 106 fixed to the shaft 30 (see Figure 10). The mass 105 is in a like manner subjected to the action of an internal spring so that it can set on the trigger of the microswitch 104 only by the effect of centrifugal force deriving from the rotation of the shaft 30.

Microswitches 100 and 104 allow the mandril to describe fret-like movements by means of the alternation of longitudinal and transversal travels of the type illustrated in Figures 18 and 19.

These microswitches are actuated at every turn of their respective shafts.

In the case of Figure 18, the span performs initially a transversal travel from A to B, as the motor 16 is "on" and the motor 26 is "off." At point B the rotating cam 101 engages the trigger of the microswitch 100 which causes motor 16 to stop and motor 26 to start thus initiating the longitudinal travel of the carriage from B up to C. At this point the rotating cam 105 encounters the trigger of microswitch 104 thus stopping motor 26, and starting motor 16 in the opposite direction to its previous one. In this way the travel from C towards D takes place and at D the rotating cam 101 again meets the trigger of the microswitch 100 whereby motor 16 is stopped and motor 26 is started in the same direction as before, and so the shift from position D to position E is obtained and so on.

The cycle according to Figure 19 is brought about by so setting the electrical apparatus coupled to the microswitches 100 and 104 that the successive longitudinal travels of the carriage take place when motor 26 changes its direction of rotating instead of motor 16 as in the previous case, while motor 16 performs successive travels in the same direction.

The cycle illustrated in Figure 20 consists of a sequence of longitudinal and transversal travels such as to follow the perimeter of the slab being treated. This cycle can be obtained by cutting out microswitches 100 and 104 and simply using the travel-limiting microswitches 33 and 40.

The cycle shown in Figure 21 corresponds to the simplest case and is obtained by alternate movements of the carriage alone along the span, using microswitch 40.

The electrical equipment with its control push-buttons for starting and stopping the machine are contained, in known fashion, in a panel which can also be placed at a distance from the machine in order to permit remote control thereof.

Each of the motors 16 and 26 is fitted with a brake consisting of a band 108 wound round the motor shaft, and an interposed member 109 with a high frictional coefficient. The pressure of the band 108—109 on the motor shaft can be adjusted by means of a screw 110 so as to obtain regulation of the strength of the braking effect. The braking is found to be useful for absorbing the momentum of the motors when reversing the direction of movement.

The machine heretofore described, since its working movements are automatically controlled, gives scope for a considerable reduction in overall working time and hence in the employment of manpower.

Moreover the time required to set up the machine at the beginning of a job and between

jobs on the same slab, for example between degreasing, smoothing and polishing, are reduced to the minimum as the tools can be rapidly attached to the mandril and hence can easily be changed.

It is manifest that many variations can be made to the machine described without departing from the protective ambit of the inventive concept defined by the following claims.

WHAT I CLAIM IS:—

1. A flat surface grinding and polishing machine having a polishing head with planetary arranged polishing and grinding tools having the polishing surfaces thereof rotating in their own planes and arranged perpendicular to the driving shaft of the polishing tools and with a carriage raisably and depressably supporting the said polishing head and adapted to run on carrying tracks which are movable in a direction transverse to the movement of the said carriage, characterized in that on said carriage a swinging transmission unit is arranged which co-operates with the driving shaft of the polishing head and imparts thereto additionally a circular swinging motion in a plane parallel to the grinding and polishing surface of the grinding tools.

2. A flat surface grinding and polishing machine according to claim 1 wherein the swinging transmission unit comprises a swinging arm connected with the polishing head and a first drive for the polishing head and a second drive co-operating therewith and imparting a rotating motion to a crank drive having a connecting rod connected to the frame of the machine and causing a swinging motion of said arm during the rotation of the crank drive.

3. A flat surface grinding and polishing machine according to claim 2 in which the second drive is taken from the first drive.

4. A flat surface grinding and polishing machine according to any preceding claim in which the carrying tracks supporting the carriage run on a second pair of tracks to move the polishing head longitudinally.

5. A flat surface grinding and polishing machine according to claim 4 in which motors are provided upon the carriage and on the second pair of tracks to move the polishing surfaces transversally and longitudinally above the work face.

6. A flat surface grinding and polishing machine according to claim 4 or claim 5 in which travel-limiting and/or motor reversing devices are mounted on both pairs of tracks.

7. A flat surface grinding and polishing machine according to claim 6 in which the travel-limiting and/or motor reversing devices have an impinging member adapted to strike against a resilient stop fixed in an adjustable position so as to determine the end of travel.

8. A flat surface grinding and polishing machine according to claim 2 or any claim appendent thereto in which the first drive operates the planetary polishing heads by means of a vertically movable mandrel.

9. A flat surface grinding and polishing machine according to claim 8 in which the mandrel is spring loaded in the work face direction.

10. A flat surface grinding and polishing machine substantially as herein described with reference to the accompanying examples.

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Leamington Spa: Printed for Her Majesty's Stationery Office, by the Courier Press (Leamington) Ltd.—1964. Published by the Patent Office, 25 Southampton Buildings, London, W.C.2, from which copies may be obtained.

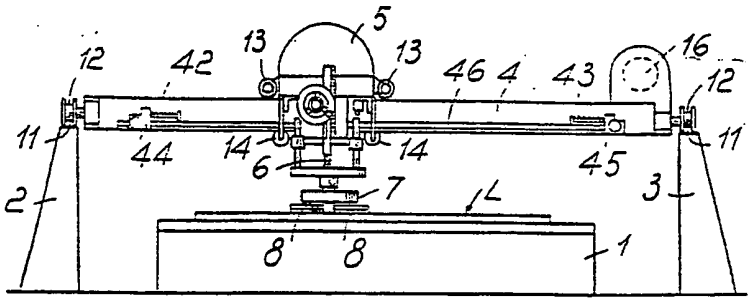

Fig. 1

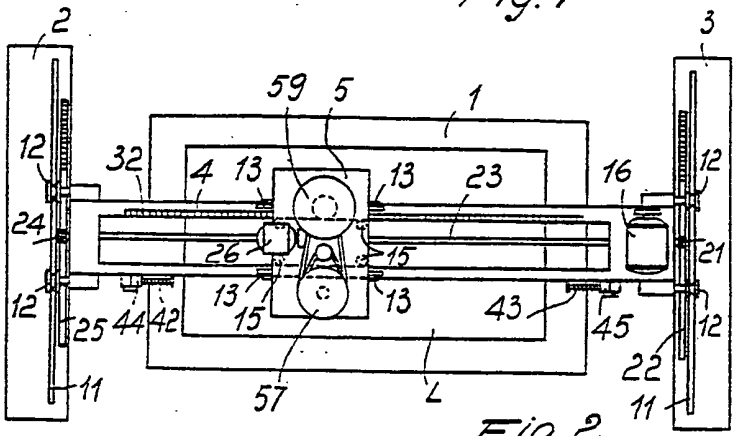

Fig. 2

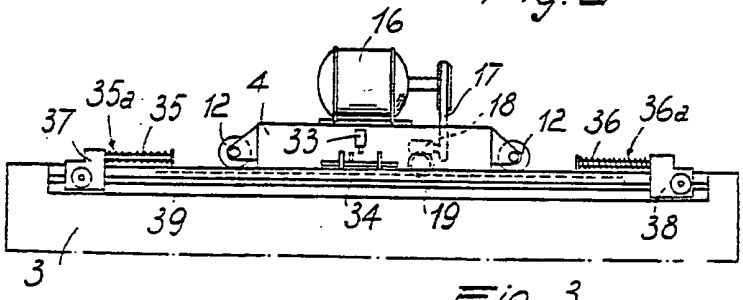

Fig. 3

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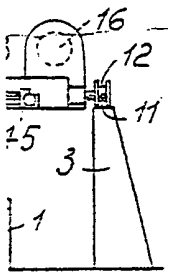

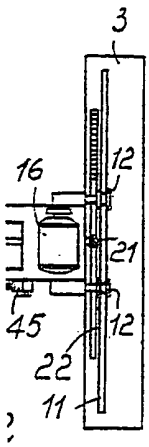

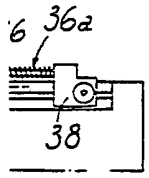

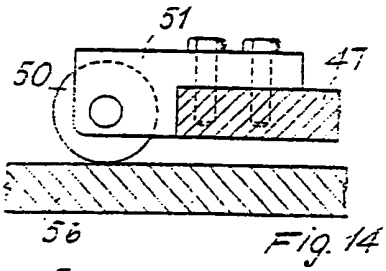

Fig. 14

Fig. 10

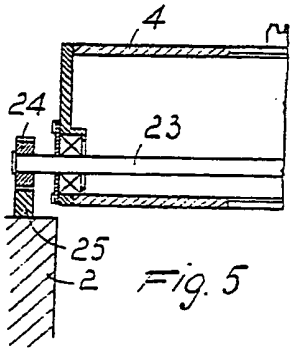

Fig. 5

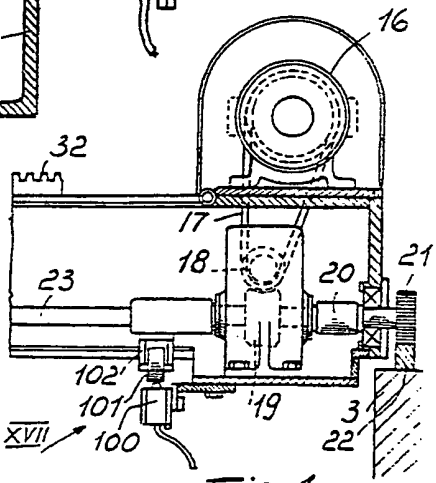

Fig. 4

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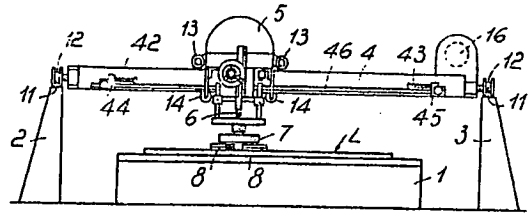
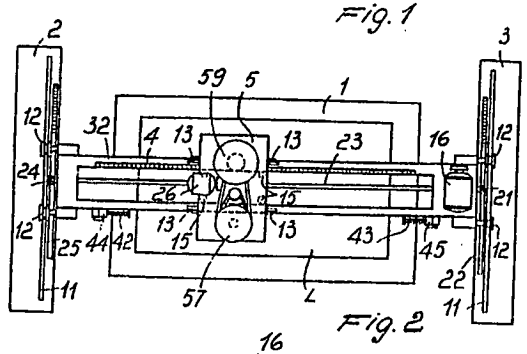


Fig. 1



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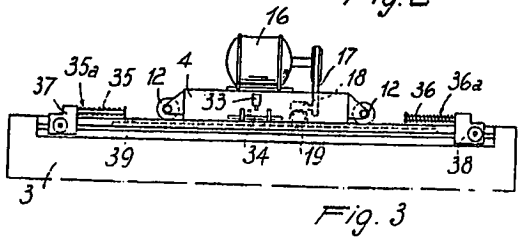

Fig. 3

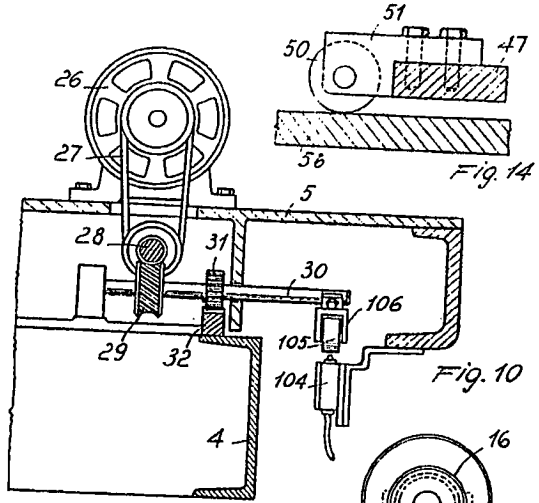

Fig. 14

Fig. 10

Fig. 5

Fig. 4

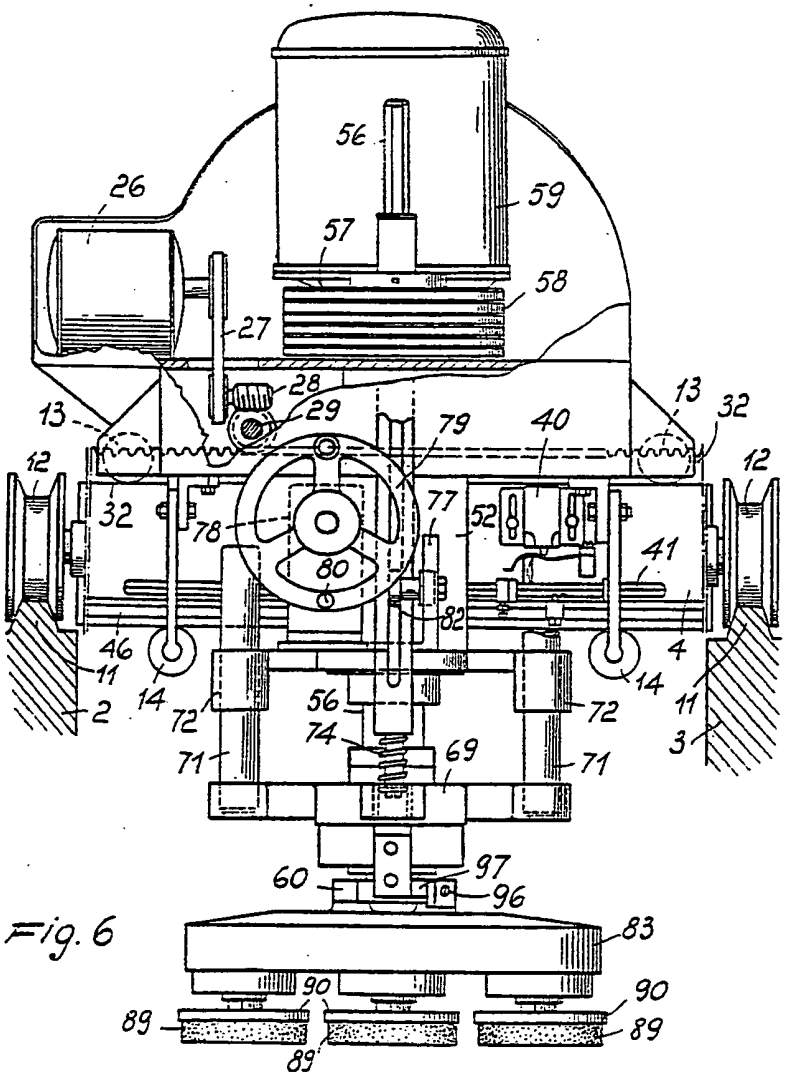
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Fig. 6

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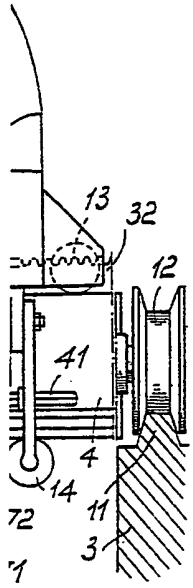

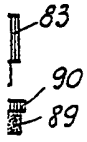

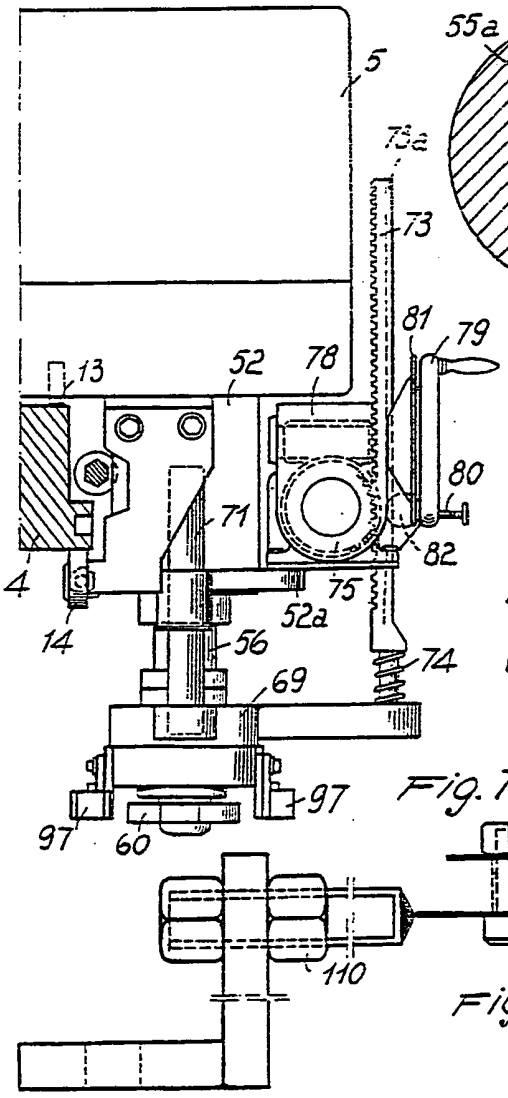

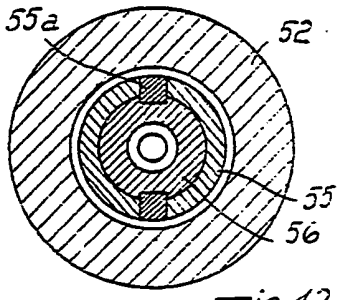

Fig. 12

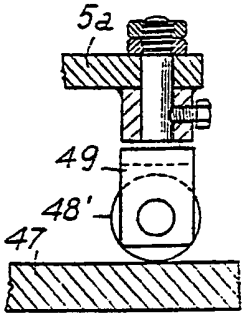

Fig. 13

Fig. 7

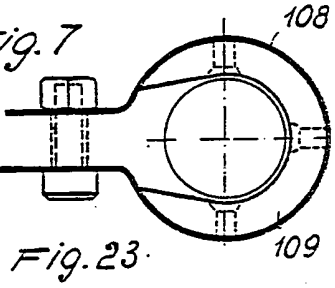

Fig. 23.

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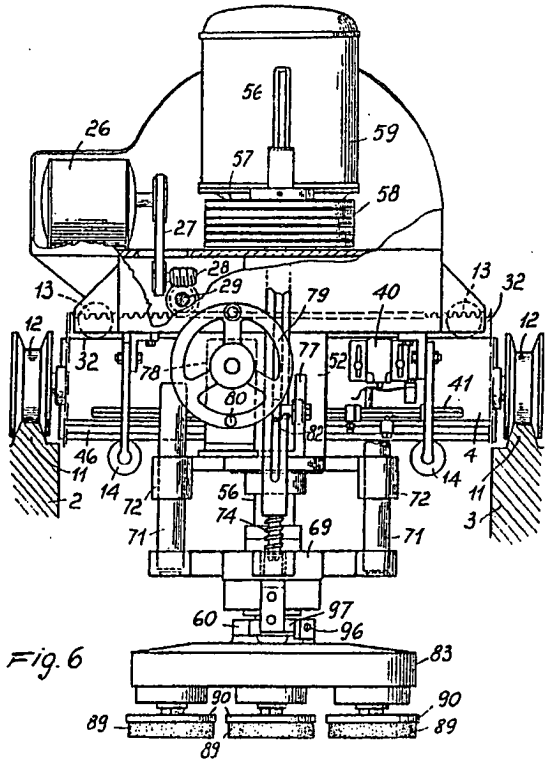


Fig. 6

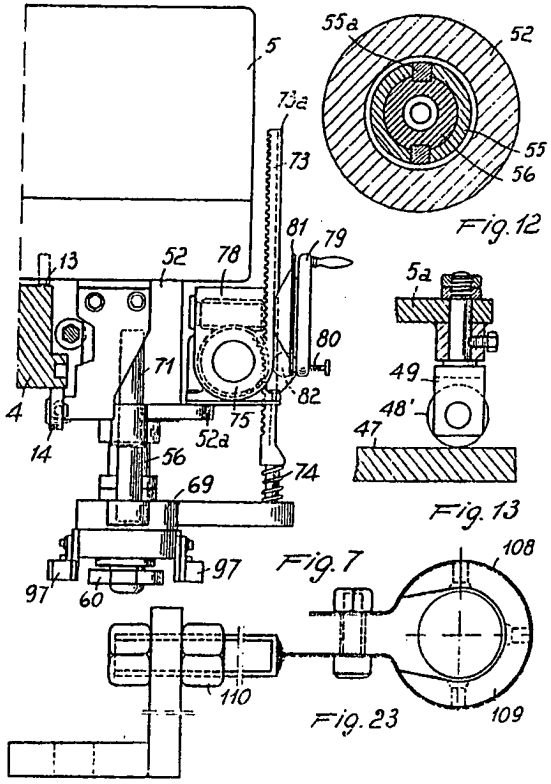
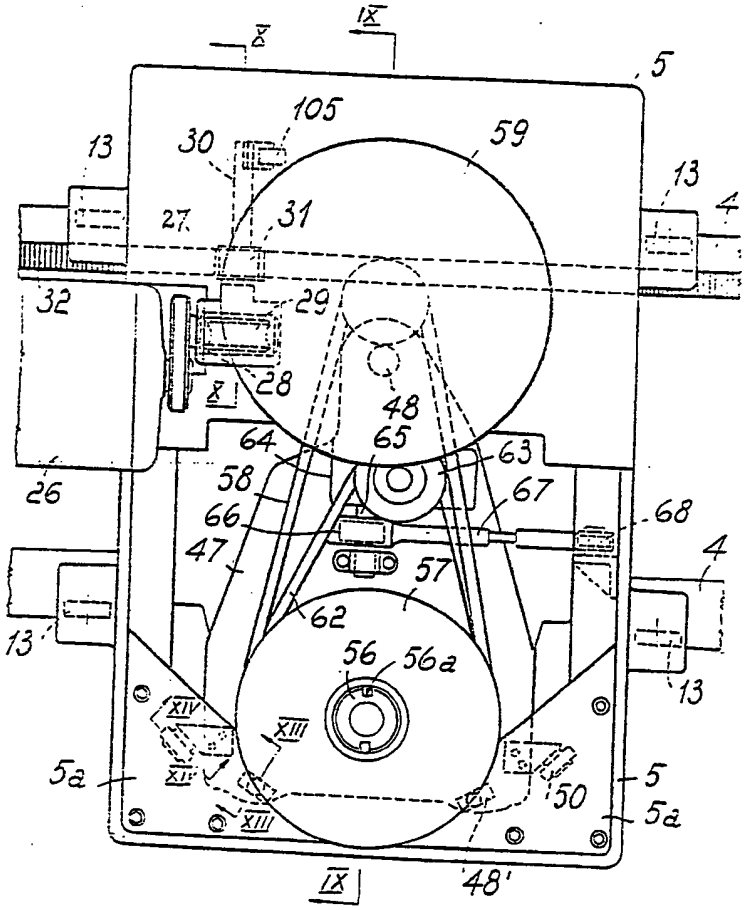


Fig. 7

Fig. 12

Fig. 13

Fig. 23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68
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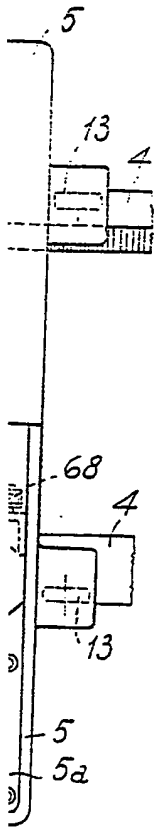
57
62
13
56
56a
13
XIV
XIII
XII
5a
5
50
5a
XIII
IX
48'

Fig. 8

972693 COMPLETE SPECIFICATION
8 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheets 5 & 6



9. 8

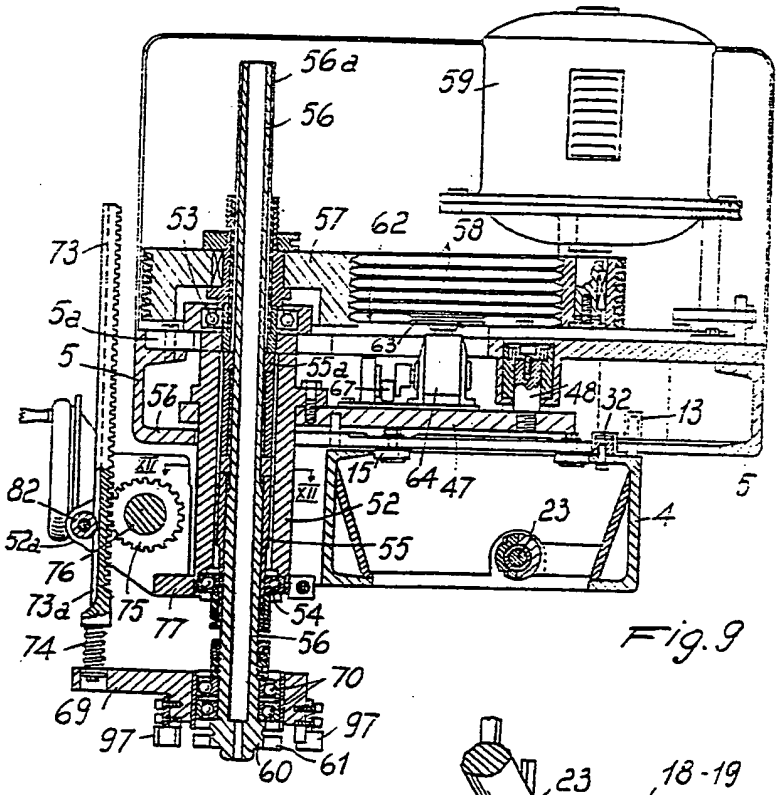


Fig. 9

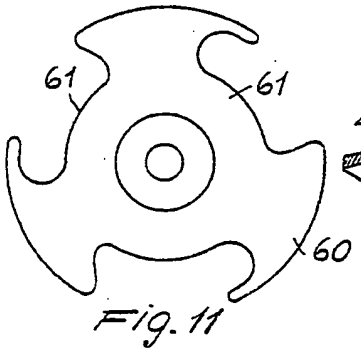


Fig. 11

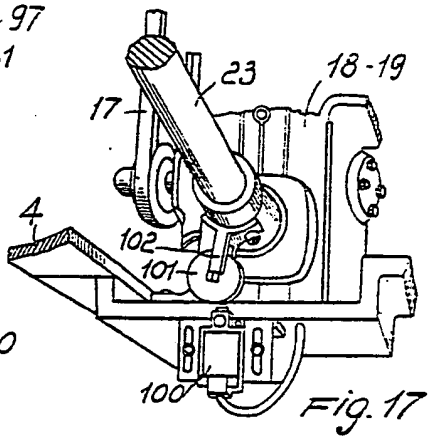


Fig. 17

972693 COMPLETE SPECIFICATION
8 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheets 5 & 6

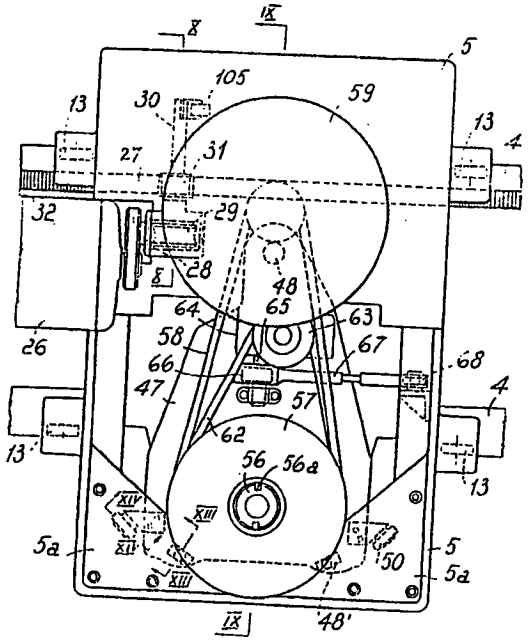


Fig. 8

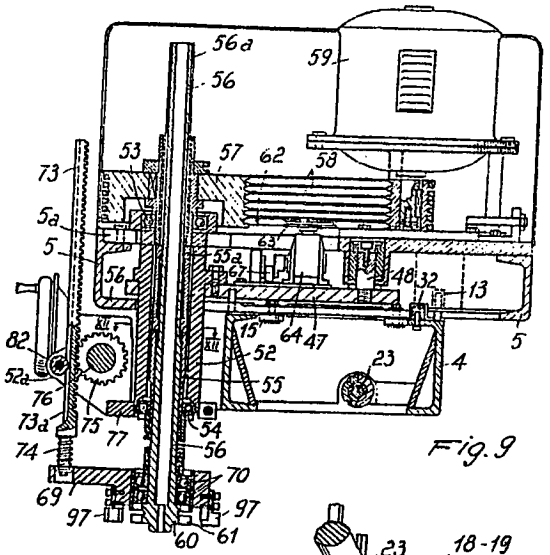


Fig. 9

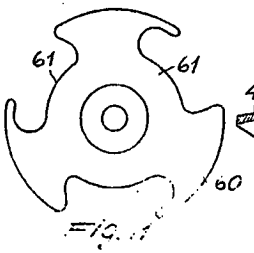


Fig. 16

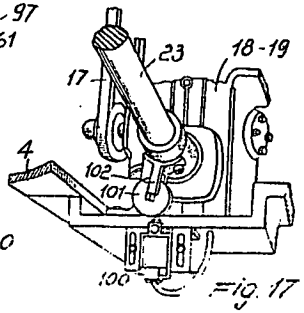


Fig. 17

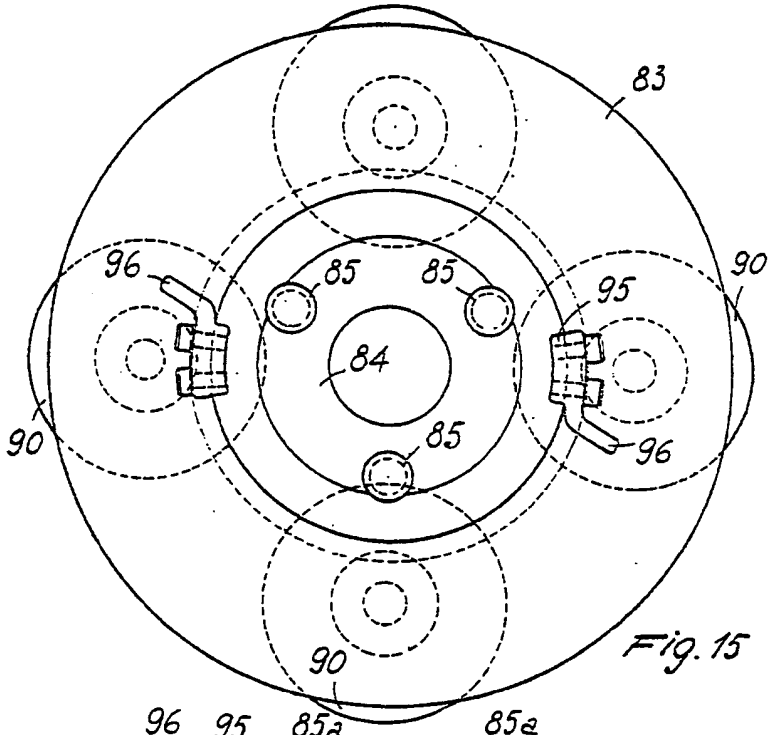

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Fig. 15

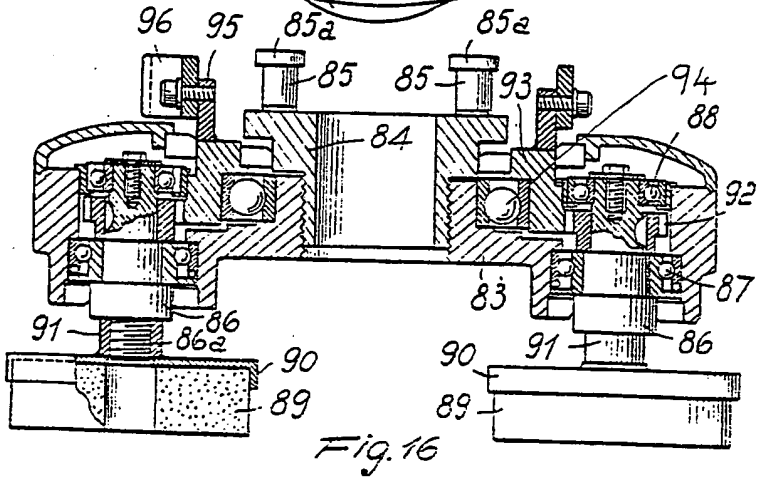
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Fig. 16

972693 COMPLETE SPECIFICATION
8 SHEETS *This drawing is a reproduction of the Original on a reduced scale*
Sheets 7 & 8

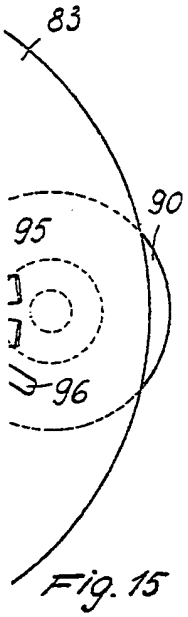
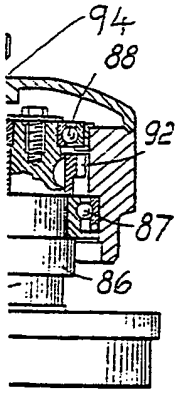


Fig. 15



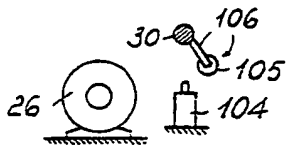


Fig. 18

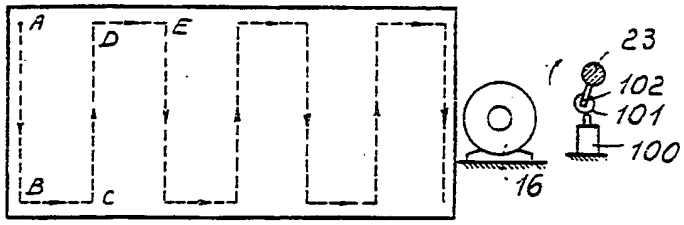


Fig. 19

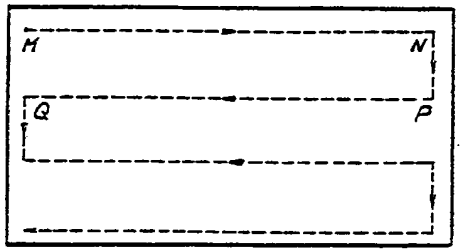


Fig. 20

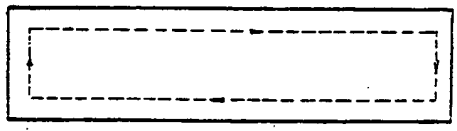
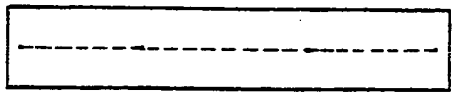


Fig. 21



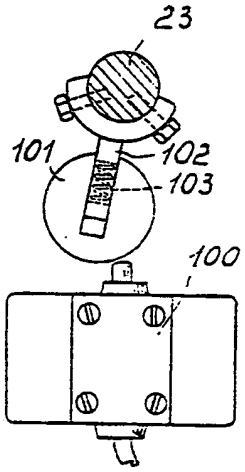


Fig. 22

972693 COMPLETE SPECIFICATION
8 SHEETS This drawing is a reproduction of the Original on a reduced scale
Sheets 7 & 8

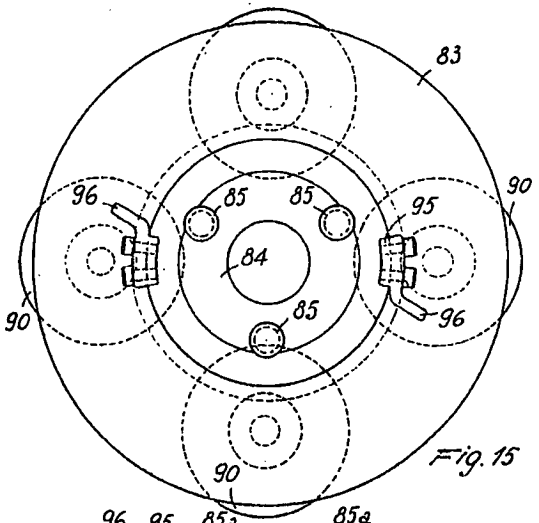


Fig. 15

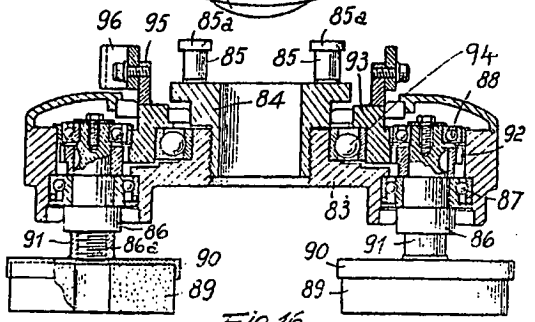


Fig. 16

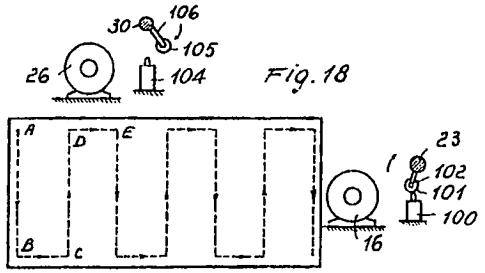


Fig. 18

Fig. 19

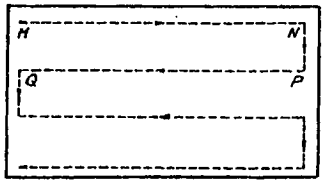


Fig. 20

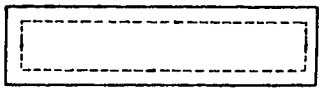
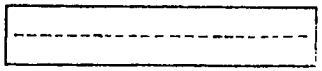


Fig. 21



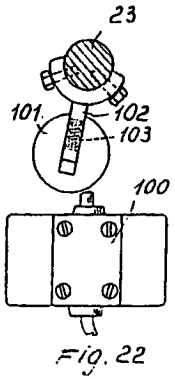


Fig. 22